EMS Response Time and Hospital Length-of-Stay in a Remote Setting.

Holly Billie, Class of 1996.

Trauma is one of the leading health problems in rural areas. Rates of death from unintentional injury are 50% higher in rural than in urban areas; for motor vehicle injuries, the differential is nearly two-fold.[1,2] A number of factors are thought to explain these higher mortality rates. These include the sparse distribution of population and medical resources, higher speeds on rural roads, unlighted roads often poorly marked, long distance or transport times from emergency medical service (EMS) base stations to crash sites, and lower prevalence of emergency medical technicians trained in advanced life-support techniques.[3-6]

Higher rural death and injury rates apply to the sparsely-populated Navajo Nation. Injuries are one of the leading causes of death and hospitalization on the Navajo Nation. Between 1990 and 1992, 22.6 % of all deaths on the Navajo Nation were caused by injuries. In 1985, motor vehicle related deaths (83.7/100,000/year) accounted for more than half of all injury deaths. The rate of motor vehicle injury hospitalization (307/100,000/year) was followed by falls and homicide attempts.[7]

Like the many rural communities of the Navajo Nation, residents of the Montezuma Creek, Utah, area face special problems in receiving medical care. Montezuma Creek is located 60 miles from the nearest hospital and the lack of telephones and a 911 system, inadequate mapping and numbering of roads and residences, sparse homes and poor roads hinder quick ambulance response in this community. These facts often contribute to extended response times, and the long distances between homes often cause unavoidable delays. Long delays are likely to affect patient outcomes.

Setting

Southeastern San Juan County is part of the Navajo Nation known as the Utah strip. San Juan County is a rural county, encompassing 7,821 square miles, with an estimated population of 13,500 and a 1.7 population density per square mile. Approximately 6000 Navajos live in the county, of which 2,200 live in Montezuma Creek.[8]

San Juan County EMS has one ambulance which serves the Montezuma Creek area. Eight certified emergency medical technicians (EMTs) are on staff. Seven are trained in basic life support and one has intermediate EMT training with IV administration. No paramedics are on staff due to the low volume of ambulance runs. The state regulations require paramedics only in areas with high volume ambulance runs. The Montezuma Creek ambulance serves the population on the Utah strip and usually will bring patients to the Blanding Clinic, located 37 miles north of Montezuma Creek. The patient is transported to the nearest facility that can provide care unless EMTs are directed to transport the patient elsewhere by a physician at Medical Control, Blanding Clinic. If a patient is not taken to the Blanding Clinic, they will usually be taken to one of three hospitals located in Utah, Colorado, and New Mexico (all approximately 60 miles from Montezuma Creek). Eighteen of the 36 subjects were transferred by air ambulance to hospitals as far away as Salt Lake City, Utah (335 miles). EMTs are authorized to call an air ambulance if the patient meets one or more trauma triage criteria.[9]

The closest level II-equivalent trauma center is a 159 bed facility in Farmington, NM, 90 miles from Montezuma Creek. The closest level I-equivalent trauma center is located in Salt Lake City, Utah. Patients were hospitalized in 9 different hospitals in the Four Corners region. Fifty percent of the patients required level II or higher care.

METHODS

This was a retrospective cohort study. Patients were identified from Montezuma Creek ambulance response reports and tracked until death or discharge from the hospital. Patients were included if they had a completed run sheet to an EMS response from January,1994 through June,1996, and were hospitalized. County residents, non-residents, Indians and non-Indians were included in the study. Injuries included were those with E-Codes from 800 to 999: falls, falling objects, motor vehicle crashes (including collisions with pedestrians) and assaults. Injuries from burns and suicide attempts/completions from poisoning were excluded since injury severity and survival probability could not be calculated for these types of injuries.

Data Collection

Data were abstracted from several sources: EMS run sheets, emergency department medical records, inpatient records for local hospitals, and hospital-based trauma registries for patients transferred to large institutions. The information abstracted from these records is summarized in Table I. Abbreviated Injury Severity (AIS) Scores were assigned using a computer program which matches International Classification of Diseases (ICD-9)-coded injuries to abbreviated injury severity scores.[10] Probability of survival was calculated using the same program.

Table I. Data sources and elements

Agency Type	Source	Elements
EMS	Run reports	injury type, time, location,

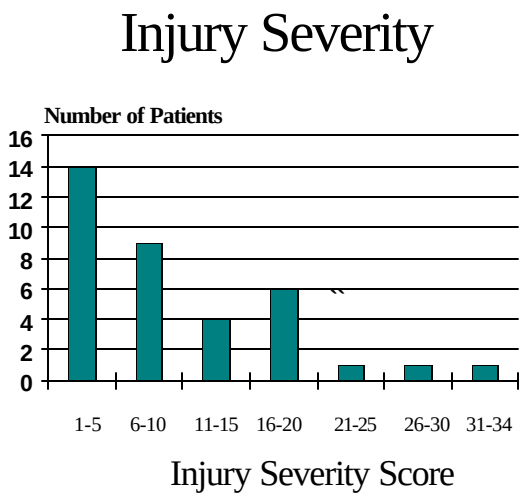
		vital signs, destination, response times, distances
ER	Medical record	demographic data, vital signs, disposition, transport type
Hospital admission	Medical record	arrival, discharge dates, ICD-9 injury diagnoses codes (highest AIS per body region) ISS, E-Code, length-of-stay, days in Intensive Care Unit, disposition

Total ambulance-response time and response interval were calculated for each patient. Regression analysis was performed between the variables length-of-stay and total response time.

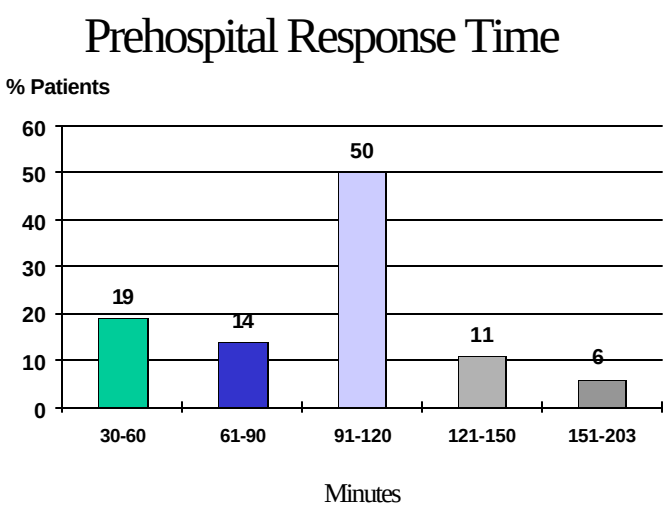
Results

There were 259 ambulance runs from January, 1994 to June, 1996. Thirty-six patients met study criteria of which 58% (21) were male and 42% (15) were female. The mean age was 26.4 years with a range of 2 to 85 years. The most common mechanism of injury was motor vehicle crashes (50%), followed by falls (19%), pedestrian injuries (14%), and assaults (8%).

The median injury severity score (ISS) was 9.0, with a mean of 10.6 and a range of 1 to 34 (Figure 2). Two patients died. The majority of patients had an ISS of less than 15 and by definition were not major trauma cases. Only 8 out of 36 patients had an ISS above 15. The average hospital stay for all patients with an ISS lower than 15 was 6 days. The average stay for patients with an ISS higher than 15 was 10.2 days. The total overall average was 7.6 hospital days. Nine patients spent an average of 6.1 days in the hospital intensive care unit.



The prehospital intervals from the time the call was received until the arrival of the patient at the emergency department are shown in Figure 3. The mean response time (time of dispatch to ambulance enroute) was 6.8 minutes with a maximum of 25 minutes. The mean “to scene” time (ambulance enroute to scene arrival) was 12.9 minutes, with a maximum of 29 minutes. The mean “on scene” time (scene arrival to scene departure) was 21.4 minutes, with a maximum of 57 minutes. The mean transport time (scene departure to arrival at the emergency department) was 54.2 minutes, with a maximum of 168 minutes. The mean total prehospital time was 95.1 minutes with a range of 30 to 203 minutes.



Eighteen patients were transported by ground ambulance only. Four patients were transported from the scene of injury directly to an air ambulance. Fourteen patients were transported by ground ambulance, then later by air ambulance.

Regression analyses yielded the following results:

Length of stay = -1.76 + (.038 x Response time) + (.5229 x ISS) + (.00 x Age)
95% Confidence -.029 to .108,.212 to .833, -.138 to .071

Hospital days (length of stay) increase as a result of longer EMS response times. However, the 95% confidence intervals overlap zero so that the result could have occurred from chance alone. Age is also not statistically significant, but the hospital days were significantly higher as injury severity score (ISS) increased.

Discussion

The rapidity of EMS response is thought to be a key variable in the delivery of rural trauma care. Although strong evidence linking improved outcome to specific response times is difficult to find, most rural standards call for victims to arrive at the hospital within 30 to 60 minutes.[11] Because of the large distances between the ambulance station, injury sites and hospitals, long intervals between the injury incident report and definitive care were expected. These intervals were longer in duration than those reported in other studies; however, the setting for previous studies has been urban or rural/suburban.

In this study, prehospital time was the primary focus in a large spectrum of factors in trauma care delivery because this is an area where improvement is thought to be feasible. EMT training could be expanded, and roads could be mapped, marked, and maintained. A study which found a relationship between extended EMS response and outcome would have provided justification for localized EMS in other remote communities on the Navajo Nation. At present, few communities have an ambulance or EMTs.

There are several potential limitations to this study. The time of injury to the time the incident was reported was not addressed in this study. Obtaining this information and approximating the time of injury occurrence was not included due to time constraints. If length of prehospital time effects outcome, this time interval would also have an effect and should be included, if possible, in future studies. In addition, the use of EMS data may have led to the omission of severe trauma cases in the community because some trauma patients may go directly to an emergency department by private vehicle.

Conclusion

The results do not show a large effect of response time on hospital length-of-stay but statistical power was limited by a small sample size. No other studies were found which examined response time and hospital length-of-stay. I suggest that future studies using a larger sample size be performed before the hypothesis is rejected.

REFERENCES

1. Baker SP, O'Neill B, Ginsberg MJ, et al: *The Injury Fact Book*, 2nd ed. New York, Oxford University Press, 1992, p. 224.
2. Baker SP, Whitfield RA, O'Neill B: Geographic variations in mortality from motor vehicle crashes. *N Eng J Med* 316: 1384, 1987.
3. U.S. Congress Office of Technology Assessment: Rural Emergency Medical Services-Special report (no. OTA-H-445). Washington, DC, 1989.
4. Waller JA: Rural emergency care: Problems and prospects. *Am J Public Health* 63:631, 1974.
5. Rutledge R, Messick J, Baker CC,et al: Multivariate population-based analysis of the association of county trauma centers with per capita county death rates. *J Trauma* 33:29, 1992.
6. Brodsky H, Hakkert AS: Highway fatal accidents and accessibility of emergency medical services. *Soc Sci Med* 17:731, 1983.
7. Department of Health and Human Services: Injuries among American Indians and Alaska Natives. Indian Health Service, 1990.
8. Nangle B: Utah's Vital Statistics Annual Report: 1995. Utah Department of Health.
9. San Juan Ambulance Service: Trauma Triage Criteria.
10. Cales RJ, Trauma Exclamation Point Computer Software.
11. Esposito TJ, Lazear SE, Maier RV: Trauma Care Systems Development: Evolution and Current Trends. In Maull K, et al (eds): *Advances in Trauma and Critical Care*, Vol 6, St. Louis, Mosby, 1991, pp 115-131.